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Towards Inter-Organizational Environmental Information Systems for Sustainable Business Networks

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ABSTRACT

Value creation that incorporates Environmental Performance Indicators (EPIs) requires collaboration among different supply chain entities. This especially holds for product-level indicators, since the required resources are scattered along the whole supply chain. Prevailing environmental information systems (EIS) do not support flexible collaboration among involved supply chain partners. The paper at hand provides a contribution in this area by proposing an innovative architecture artifact for inter-organizational EIS (IO-EIS). The architecture was developed by following the design science approach: The requirements on IO-EIS were extracted together with industry representatives based on three use cases. An in-depth and systematic literature research was applied to identify published critical success factors for networked information systems. The proposed architecture artifact was designed based on the findings of the two analysis steps.

Keywords

Business network, supply chain collaboration, environmental information system, environmental performance indicator

INTRODUCTION

During the last decade, the awareness for safe and environmental friendly products and services has been growing constantly (Seuring and Müller 2008). This changed economic background has lead to many challenges and opportunities for organizations.

More and more environmental directives have been passed during the last years, the majority in the European Union (EU). Worldwide, governments are regulating the declaration and use of substances of very high concern (Percival, Schroeder, Miller, and Leape 2009), the emission of CO2 (Sekar, Parsons, Herzog, and Jacoby 2007) as well as the reporting of sustainability performance. Companies can expect that in the near future, even stricter regulations are to be enacted.

Social environmental awareness is also an important driver for companies to extend their responsibility for products and make sure they are environmental friendly (Amacher 2004). Besides maximizing short-term profit, organizations are increasingly being held accountable for their impacts on society and environment (Tian and Sun 2010). For this purpose, it is in every organization's interest to be able to measure its own impact in order to be able to report, react to criticism and take counteractive measures, if necessary.

Being aware of all material included in the production process also inherits competitive advantages. First of all, it minimizes the risk of environmental non-compliance. Another advantage of collecting material data is being able to quickly react to current incidents and problems. If a quality or safety issue occurs, material and product structure information can serve as an enabler for finding out about potential reasons.

In order to fulfill the standards of voluntary eco labeling, information about substances and processes used in the product life cycle has to be available. As identified during a use case analysis, acquiring data throughout increasingly complex supply chains (Manuj and Mentzer 2008) is becoming a problem with conventional data collection tools. The existence of incompatible standards, requirements and processes complicates this even further. New EIS solutions are required which will suite the specific requirements for inter-organizational exchange of EPIs. The paper at hand provides a contribution in this context by considering the following research questions:

- What are the specific requirements upon IO-EIS?
- What is a suitable architecture for IO-EIS?
- Collaboration in supply chains is not a new topic and new solutions can be developed more efficiently by drawing upon existing knowledge. Thus, the third research question is: What is the relevant existing knowledge regarding critical success factors for networked IS that can be applied for designing an architecture artifact for IO-EIS?

These research questions are also motivated by the research of Melville (2011), who identifies a gap in current literature of investigating IS and their association to supply chain environmental performance as well as suitable IS to influence human actions about the natural environment.

Based on requirements analysis from use cases and intensive literature research about already published structures and success factors of networked IS, an architecture artifact for IO-EIS is proposed. The content of the paper is structured as follows: Chapter two provides a description of the research methodology while chapter three summarizes the results of the use case and literature analysis. Chapter four contains the description of the resulting architecture artifact and chapter five concludes the paper with a summary of the results and an outlook to further research.

RESEARCH METHODOLOGY - DESIGN SCIENCE APPLIED

For answering the research questions motivated in the previous section and characterized by a practical nature, the design science approach was adopted as illustrated by figure 1. Design science research aims at solving practical and theoretical problems by creating and evaluating IT artifacts intended to solve identified organizational problems. Hence, it is considered as a problem-oriented approach (Hevner, March, Park, and Ram 2004). To come to rigorous and relevant research results, we draw upon on Peffers, Tuunanen, Rothenberger, and Chatterjee (2007) to specify the following phases of the design science research process applied:

- *Problem Identification and Motivation.* In the first section a summary of drivers for IO-EIS was presented, the research problem was specified, and the practical relevance of a solution was discussed. Based on the problem scope, the research questions guiding this paper were defined.
- *Define the Objectives for a Solution.* The objectives of a solution are inferred from the problem definition and knowledge of the state of problems. The problem scope was assessed in cooperation with industry representatives. Based on industry input three industry use cases that are highly relevant in the field of sustainability research were identified and served as basis for requirements identification.
- *Design.* Research on inter-organizational IS (IOIS) has a long tradition. In order to be able to incorporate existing knowledge about success factors of IOIS existing knowledge was summarized based on an in-depth and systematic analysis of relevant literature. Based on the requirements from the use cases and the findings from literature research, a new design of an architecture artifact for IO-EIS was developed.
- *Demonstration and Evaluation.* A first evaluation of the proposed architecture was conducted at a workshop with users that participated in the development of the use cases.

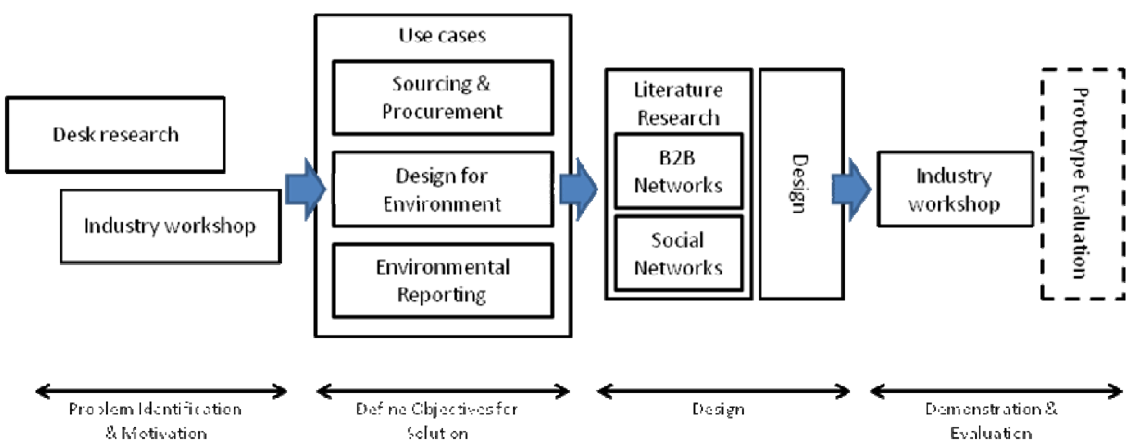

Figure 1. Research Methodology

The results of each of the applied analysis and the design process activities are presented in the remaining part of the paper.

RESULTS

Use Cases

This section describes three use cases with high sustainability and financial impact thereby illustrating why inter-organizational business processes and EPIs should be aligned more closely in order to improve in both areas. The use cases were selected to analyze the business-driven need for new IO-EIS. The identification, selection and description of the use cases was performed in cooperation with four industry partners: one global high-tech company, one global elevator manufacturer, one leading enterprise software company and one major European telecom operator. The selection of these partners made sure that a diverse set of industries was involved and therefore industry-specific challenges could be identified during the process. In a first workshop relevant use cases related to IO-EIS were selected using the above mentioned criteria. Than through several workshops and discussions as well as interviews with responsible employees at the involved companies the use cases were described and requirements extracted.

Sourcing & Procurement

The sourcing and procurement use case outlines the current environmental considerations pertaining to supplier management and operational purchasing. The high-level goal of this use case is to decrease the environmental impact across the product life cycle. This is achieved via including EPIs in benchmarking of suppliers of the same material with regards to specific EPIs and in the purchasing decisions, in particular for materials with high business and environmental leverage.

Within sourcing and procurement, environmental information already plays a role in supplier management, material compliance and environmental assessments. Supplier management includes the evaluation of suppliers against several criteria such as quality, service, and financial aspects. Annual supplier evaluations typically follow an explicit program that includes setting performance categories and their weights, supplier scoring, and improvements. Environmental criteria are also part of this evaluation process, however they mostly comprise binary requirements that have to be fulfilled, e.g. existence of a certified environmental system, energy reduction programs, etc. Because the questions are yes/no questions that all accepted suppliers have to meet, different suppliers of the same product are not differentiated in their environmental performance.

The operational procurement function has the responsibility of carrying out the purchasing activities of a specific division, e.g. product line or business unit. Also, they should ensure that material-level environmental compliance requirements (e.g. WEEE and RoHS-compliance for electronics components) are included in the normal supplier contracts. Because of the compliance-driven nature, these requirements cannot be used to achieve environmental improvements: suppliers either comply or not, and there's no basis for comparing compliant suppliers.

Design for Environment (DfE)

DfE is a general concept that refers to a variety of design approaches that attempt to reduce the overall environmental impact of a product, process or service across its life cycle. Based on product and process data, the environmental impacts of different alternatives have to be calculated and compared. DfE deals with several topics like environmentally- conscious manufacturing, design for disposal, and packaging related topics. Besides the identification of weak points of a solution and the comparison of alternatives, the tradeoff between decisions in different life cycle phases has to be investigated. The goal is to identify the design alternatives within the product lifecycle that can enable environmental impact reduction at minimal additional costs.

The high-level goal of this use case is to decrease the environmental impact of products along its life cycle. This is achieved via including EPIs in the comparison of design alternatives. Life Cycle Assessment (LCA) is a part of the comparison and the following processes address two major process steps of LCA:

- Data inventory analysis (collecting data, calculation, allocation)
- What-if-scenarios as part of life cycle interpretation

Life Cycle Assessment (LCA) is conducted by environmental experts. The current process often is characterized by a time-consuming information retrieval from different databases, spreadsheets and other information sources across organizational boarders, which currently leads to incomplete data and high costs. The main process steps applied to LCA are:

- Goal and Scope (Define system boundaries, data quality)
- Data inventory analysis (collecting data, calculation, allocation)
- Life cycle impact assessment

- Life cycle interpretation (weak point, what-if-scenario and sensitivity analysis)

Environmental Performance Reporting

The communication of the organization`s environmental performance is an integral part of any activity related to environmental sustainability. The goal is to enable an efficient, reliable, and transparent reporting to stakeholders within and beyond the organization in an easily digestible way.

Environmental communication can be divided into two types: Regular communication efforts and ad-hoc communication. Regular environmental communication efforts, such as quarterly or annual sustainability reports, have a given structure which only evolves occasionally. The main work is related to the collection of the data, which still involves huge manual efforts. In order to retrieve the data, each facility or site has to be contacted and the data adapted for system usage. Often there are third parties involved that own the data and/or do the calculations and they too provide the data in formats that also have to be adapted. Environmental data is currently stored in multiple databases within the company, therefore for the creation of a report data has to be retrieved from different information sources. Often environmental reporting requires inter-organizational data exchange.

Ad-hoc communication efforts are triggered by a certain event, e.g. a customer request, a criticism to corporate behavior, etc. When an irregular report is created, in a first step the required data and system boundaries have to be determined. After this, the data has to be acquired. This involves accessing many data types in different locations and formats. Since not all data is available in digital format, it also involves finding people and manual work. In the next step, the data has to be transferred to an EPI calculation tool. If the data is incorrect or does not have the desired granularity, the data source and all manual processes have to be tested for correctness. Only then the EPIs for the report can be calculated.

General Use Case Challenges

Availability: The main problem in all use cases is the general availability of EPIs. Often, quantitative EPIs are not even in use, and only qualitative questionnaires are common for evaluating suppliers, for example. Company-related environmental data is scattered within the organization, while product- or supply chain-related data is even scattered across organizational borders.

Lack of comparability: In all use cases, comparability is very limited due to different EPIs, baselines, and reporting standards. In order to gain a useful comparison, one would need to be sure that both companies use the same measurement methods and assumptions. Even comparing the EPI of an organization with e.g. the value of the preceding year is difficult. Also, comparing suppliers from different geographical regions is almost impossible because of different regulations, energy mixes etc.

Inflexibility: Due to complex processes and little automation, current approaches are very slow and inflexible. Definition and implementation of EPIs can take up to a year and more, accessing all data required and calculating EPIs up to 6 months. This makes it impossible to quickly react to socio-economic changes or specific crisis situations.

Costs: The current process is often characterized by time-consuming information retrieval from different databases, spreadsheets and other information sources. Since the data is scattered within the organization or even across its boarders, a huge number of employees has to be involved. Due to the lack of automation and incompatible formats and processes, the costs of incorporating environmental data into the business processes are high.

Summary of requirements

The use cases have illustrated the requirements that a next generation networked EIS has to meet. These are:

1. inter-organizational access, sharing and collaborative further development of EPIs,
2. comparable data from network participants,
3. flexible access to system and data,
4. low costs.

Since the use case analysis made clear that existing systems do not meet these requirements, we propose the concept of a network-centric information system for B2B EPI exchange. It should have a suitable logical topology for the information exchange, facilitate suitable mechanisms for network integration and collaboration, and provide adequate and flexible data protection. This idea is to a great extent similar to that of Supply Chain Collaboration Information Systems: Through connecting all partners in the supply chain via a central data repository, the ease of sharing and accessing high quality data is improved, and the low response rates of classical one-to-one communication can be avoided. As the new solution should support collaborative creation sharing and exchange of EPIs, it should also leverage elements of Web 2.0 platforms, in particular social networks.

Given the requirements above and the similarity of the envisioned potential solution for IO-EIS, the literature analysis focuses on structures and critical success factors of supply chain IS and social networks.

B2B Networks

In order to ensure that the existing knowledge was incorporated, the literature information exchange B2B Networks was analyzed. The literature research was conducted based on the approach suggested by vom Brocke et al. (2009). After defining the search terms “business network” and “supply chain coordination”, the Proquest (ABI/INFORM) database was selected, since it contains the journals and conference proceedings that were classified as most important for this research area. The research resulted in a total of 384 results. Of those, a total of 112 papers were classified as potentially relevant by reading the abstract. This amount was further reduced to an amount of 37 highly relevant papers by screening the full paper. Furthermore, a first forward/ backward search of those highly relevant papers was conducted to identify additional papers.

The literature in the field of B2B networks can be classified in three main streams:

- *Business network structure*: Which companies collaborate with whom, what are the relations between the participating companies, and what is the overall network structure?
- *Business network performance*: The effect of business networks on the revenue and other performance measures of network members and the reasons for individual and mutual network success.
- *Business network information technology*: The conception, characterization and evaluation of technology supporting business networks.

The exchange of data can be based on three types of relationships among involved parties and respective information systems:

- *One-to-one*: Companies within the supply chain communicate directly, without any arranging topology. This implies that for every connection, the communication standard as well as the content has to be defined. The automation capability as well as the degree of freedom is very high, while the costs are very high as well.
- *One-to-many*: A logical topology where one company facilitates all its business partners to communicate within a common architecture (“enterprise centric architecture”). This simplifies communication for the company providing the infrastructure, but not necessarily for its business partners, as long as other systems are in use within the industry. Furthermore, the scalability is limited (Linthicum 2001).
- *Many-to-many*: A logical topology where all business partners use a common architecture based on a hub-and-spoke layout (“network centric architecture”). While this enables best flexibility and scalability at lowest costs as well as new network enabled capabilities (Harrison, Lee, Neale, and Whang 2004), the lock-in costs are very high and on-boarding and privacy issues become prevalent.

IS for business networks, also often referred to as collaborative supply chain systems, use the exchange of information as a mean to reduce information asymmetries (McLaren, Head, and Yuan 2002) and facilitate common decisions (Erhun and Keskinocak 2011) for the benefit of the entire supply chain. The collaboration type can be distinguished by the mechanisms of the IS (adopted from Lee and Whang (2000) and McLaren et al. (2002)):

- *Information integration*: Required to remove information asymmetries within supply chains. Relevant is any data that can influence the performance of the supply chain. The information should be available real-time at low costs (Lee and Whang 2000). A popular example is point-of-sale data or inventory data.
- *Resource coordination*: The partners plan jointly and split competencies, e.g. by the means of collaborative planning, forecasting and replenishment (CPFR, (Fliedner 2003)).
- *Process integration*: The partners use common resources and integrate and streamline their processes. This can be done by the means of contracts and/or revenue sharing (Cachon and Lariviere 2005).

IOIS can also be used in order to invent completely new business models (Lee and Whang 2000). Which type of collaboration is suitable for a certain situation, depends on the participants, their relations and the goal(s) of the collaboration. Trust is considered a main hurdle for the successful implementation of business networks and the adoption of supporting IS. Consequently, the type of information that is exchanged is also a main differentiation for IOIS.

- Public data relates to data which generally is available to the public, either already published or on request.
- Private data depicts any data that is only available within organizational boundaries. Associated organizations or partners may receive this data when required, but only under non-disclosure agreement.
- Specific data relates to any data which has to be specifically collected or created for the organization requesting it.

Mentzer, Foggin, and Golicic (2000) give a summary of factors that enable supply chain collaboration: here the ones that are repeatedly mentioned in the literature are presented:

i. Mutual trust is the facilitating factor for all network initiatives (Kwon and Suh 2004). This holds for every management level and functional area (Mentzer, Foggin, and Golicic 2000). Trust is a key enabler for mutual help and therefore also for collaboration.

ii. Intellectual property should be respected, and private information should only be accessible by authorized users (Finch 2004), while an efficient diffusion of knowledge has to be granted (Farrell 1995).

iii. Common interests/ goals are necessary in order to ensure all participants work together in every buyer-seller relationship (Dwyer, Schurr, and Oh 1987). The expectations and network roles should further be communicated clearly.

iv. Value proposition for all participants means that all network members should benefit, if possible equally, from participating (Mentzer, Min, and Zacharia 2000).

v. Technology is necessary as an enabler for next generation networks. The ubiquitous internet technologies have enabled the low-cost, standardized exchange of real-time information and collaboration which can be used by the ordinary/non-technical business user (Lee and Whang 2000).

Social Networks

Since the envisioned EIS shall leverage the potential of the Web 2.0, a literature analysis about social networks was conducted. A total of 48 literature sources were identified, out of which 9 were classified highly relevant as they actually discussed success factors for social networks. These factors were extracted in a next step. Due to slightly different focus and terminology the factors were mapped and common terms were defined. Figure 2 summarizes the success factors of social networks that were identified during the literature review process, grouped in the three categories “content”, “users” and “platform”.

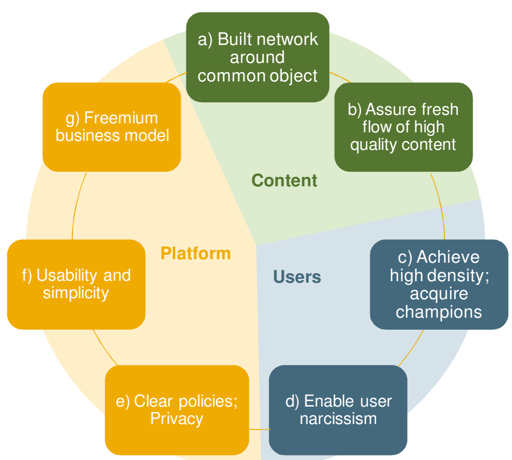

Figure 2. Relevant Success Factors from Social Networks

Content

All successful social networks were identified to be not just a network of social connections, but they add content in order to actually provide value to the members (Lacy 2009). This content has a focus on a certain common object of interest around which the network is grouped. Examples of common objects of interest in well known social networks are: short status messages in Twitter, music in MySpace and pictures in Flickr.

Since the content is user-generated, the social network has to assure a fresh flow of high quality content (Jin, Cheung, Lee, and Chen 2009). The network has to set the framework, guidelines and tools that make users want to join the network, visit on a regularly basis and participate.

Users

To keep a network attractive, it needs to have a high density more than to have a big number of participants; the relevant people for a certain user need to be on the network in order to consume interesting content and communicate efficiently (Wittie, Pejovic, Deek, Almeroth, and Zhao 2010). After conquering the smaller user group, the network can be enhanced to a wider circle. A prominent example is Facebook, which started exclusively for Harvard students and then step for step was opened to students of other top ranked colleges until it was finally made publicly available. To win users, it is necessary to win "champions", users which have a big amount of social connections and affect other users to join the network. These lead users also provide content that makes the network more interesting and therefore incentivize revisiting the network. Besides consuming content, users also leverage social networks to present themselves and their interests (Marturano and Bellucci 2009). The investigated literature refers to this as "enabling user narcissism". In a business network, this means that not only every organization but every user should see a value in using the network, ideally not only as an employee of the participating company but also as an individual.

Platform

In order to animate the user to participate, the network should set a clear framework, including policies for inadequate content and privacy definitions (Antoniou and Kalofonos 2008). A more distinct way of making privacy definitions enables users to post content without worrying, and on the other hand the maximum number of other users being authorized to access the content, maximizing the utility for the network. Especially since social networks mostly address a very big, heterogenic target group, the technology needs to be easily understandable and accessible (Preece 2001). Last but not least, successful social networks have profited from a "freemium" business model- basic functionality is provided without charge and only additional features result in costs (Teece 2010). Often this functionality is provided "on demand".

Summary of results from literature analysis

The literature analysis of B2B networks revealed that: 1) IOIS can be designed using different logical topologies. The most suitable logical topology for an IO-EIS is the many-to-many topology. It enables cooperation without imposing a hierarchy and power structures; 2) Different collaboration mechanisms can be used used as a means to reduce information asymmetries; these follow the principles of information-, resource- and process integration. With respect to relevant data to be integrated within the IO-EIS, the potential EIS has to support integration of available third-party data, exchange of private data and collection of specific environmental data. As result of the literature analysis, the following critical success factors were identified: 1) Clear value proposition for all participants and consideration of the requirements and relationships within the industry that he EIS is targeting; 2) the role of the platform as enabler and the potential advantage of platforms owned by third parties and operated as clouds; 3) content that is offered, and 4) the users.

TOWARDS INFORMATION SYSTEMS FOR SUSTAINABLE BUSINESS NETWORKS

Starting from the requirements derived from the use cases and based upon the derived existing knowledge about success factors for IOIS from the literature research, this section proposes a design for an architecture artifact for IO-EIS. Table 1 summarizes the requirements that have been extracted and maps them with the success factors extracted from the B2B network literature as well as from the social network literature. It further displays the properties of the envisioned EIS to meet these requirements.

High-level Requirement	B2B Networks	Social Networks	IS property
1. Inter-organizational collaborative access to EPIs	i. Trust and privacy ii. Efficient knowledge distribution	c. Achieve high density e. Clear policies and privacy	• Information integration, single source for accessing and sharing EPIs • Many-to-many topology • Flexible and secure data management

2. EPI Comparability	iii. Common interests/ goals	a. Build network around common object	• Offer relating information where possible (standards, regulations, etc) • EPI description language (e.g. ontology) • EPI community • Analytic capabilities
3. Data Flexibility	i. Mutual help and collaboration	b. Assure fresh flow of high quality content d. Enable user narcissism	• User participation and enablement • Multiple access channels (Web browser, mobile, backend)
4. Costs	iv. Value proposition for all participants v. Use of ubiquitous internet technology	f. Usability and simplicity g. Freemium Business Model	• Use of standard internet technology & standards • Usability and simplicity

Table 1. Summary of use-case requirements, critical success factors from literature review and IS properties

The main purpose of an IO-EIS is that of providing access to all relevant data across organizational boundaries. This requirement can be answered by providing a network-centric solution with a common database as a single access for EPIs. Duplicate and inconsistent data is also avoided by the means of information integration. Furthermore, a network solution can only work if all members of the supply chain can easily participate. A many-to-many topology is the most suitable arrangement, since it has been identified as the most scalable and cost efficient alternative. Trust and privacy have been identified as a main success factors for any business network. Organizations will only contribute, if they feel their information is in good hands and will not be misused, e.g. by the competition. On the other hand, too strict data privacy rules restrict the amount of available content and thereby the value of the network. As a consequence, a flexible data privacy mechanism, which also dynamically allows users to determine what they want to share and with whom, is a prerequisite for an IO-EIS.

Like in social networks, the content that is offered on a business network facilitates the value for the participants. Focusing on specific topics and offering as much information related to this topic as possible can help to increase the network value and data comparability. An example would be providing the relevant regulation for material compliance, e.g. by industry and region. The content that is related to the central topic should be harmonized by a data description language, e.g. an EPI ontology. The community can further drive a common understanding of the EPIs and their boundaries and calculation methodologies. Analytic capabilities enable the participants to structure content and collaboration.

For maximum flexibility, the system should facilitate collaboration by adequate channels, such as push mechanisms (messaging) and pull mechanisms (forums, task marketplaces). This also enables the use of analytical capabilities, which increase the value of the information, e.g. by industry benchmarking. A quality control of the information is also inevitable. The quality control can also be crowdsourced into the community. To facilitate user participation, the individual users should have individual profiles and personalized websites. By leveraging individual and company relationships, community enablement is enhanced. Besides offering access via a standard web browser, an interface to backend systems can simplify the participation for business users. Additionally, other access channels are gaining importance which should not be disregarded, such as mobile access or access via personalized widgets/ gadgets or mashups.

Especially for the small companies, low costs of ownership are a determinant factor. This can be met by using ubiquitous standard internet technology, and an infrastructure supporting loosely coupled services. Furthermore commonly used standards should be used wherever possible. The usability and simplicity is important to enable all users to participate and avoid frustration. Since supply networks are international, the user interface should be adapted to this circumstance.

Figure 3 illustrates the concept of the environmental IS with the described properties. Since the IS works based on the cloud paradigm on demand, no installation is necessary and implementation costs are kept low. After their identity has been approved by the provider, organizations can load their EPIs on the platform, share it with stakeholders and request access to other companies' data.

The IS supports functionality in three main areas: Transaction, analytics and collaboration. Besides the transactional use case support which is ensured through lightweight gadgets and applications on top of the platform as well as an interface for backend integration, analytical functionality can provide information about the status of the supply chain, industry averages, industry benchmarks, typical problems and solutions, extended search functionality etc. Collaboration functionality enables easy connections to partners, fast communication and problem-solving tools.

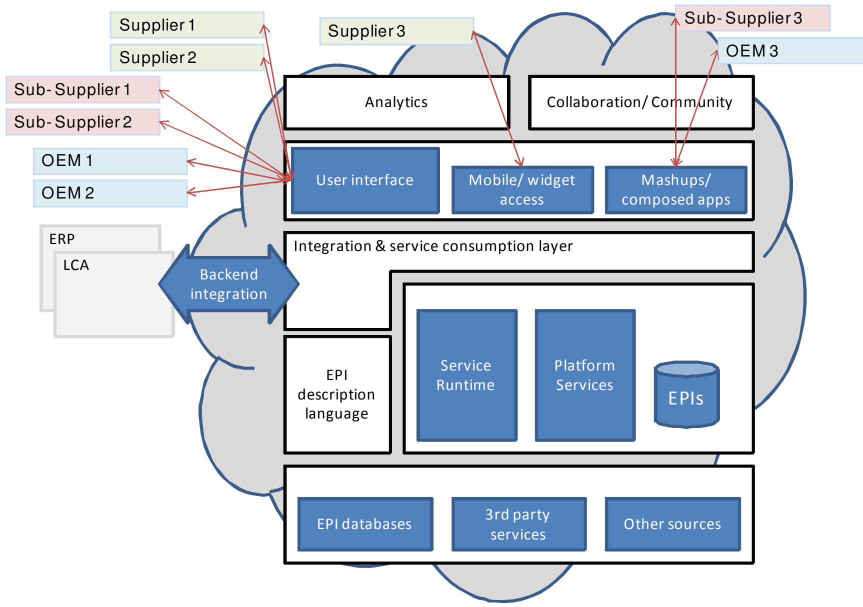

Figure 3. Network-centric EPI-sharing system

EVALUATION

During an industry workshop with the four industry partners involved in the use cases, the eligibility of this concept was elaborated. The experts agreed that this concept has the potential to solve the main problems of the status quo. The main statements of the evaluation workshop are summarized below:

EPI Availability

The system is planned as a common source for EPI data within a supply chain, or even within an industry. Thereby, it will be able to make EPIs available across organizations through standardized formats. By dramatically decreasing the amount of connections and data sources needed, while at the same time increasing availability of support and best practices through the community, providing EPIs will become much easier.

Transparency and Comparability of EPIs

With a network-centric solution, it will be easier to implement and converge towards common baselines, system boundaries and methodologies. Furthermore standardization will be encouraged by providing best practices. The idea is not to provide the standards top-down but to encourage the community to reach de-facto standards so that system boundaries and EPI calculation methodologies will converge within an industry.

Flexible Calculation of EPIs

The long periods of time that are required for the implementation of completely new EPIs can only be solved if environmental reporting becomes as much of a standard as financial reporting is today. Establishing a network-centric solution as a primary source for providing and consuming EPIs would support this process and speed up data acquisition.

However, as one expert stated, the implementation of new EPIs can only work if it goes hand in hand with a change in processes and corporate culture, including executive support.

Performance and Costs of EPI Calculation

For many experts, costs were only a secondary problem, since the availability and quality of EPIs has not reached a satisfactory point. Nevertheless, if environmental reporting and business considerations become more of a standard costs will ultimately become an important factor. With a single network, transactional costs to provide the data (once instead of per-request) will decrease. At the same time, the support of the community can help to learn best practices and enhance the speed and quality of reporting, while reducing costs.

CONCLUSION AND OUTLOOK

The aim of this paper was the design of an architecture artifact for IO-EIS. In order to achieve this, the design science methodology was applied. After defining the most relevant use cases in four industries together with four industry partners, the state of the art in those use cases was identified and requirements for a next-generation IO-EIS extracted. The requirements, in conjunction with a rigor literature research on the relevant topics of B2B and social networks laid the foundation for the design of the artifact. A first evaluation was conducted in a workshop with the industry partners. Future work will include the implementation of a prototype IO-EIS based on the architecture proposed, as well as further in-depth research on the facilitating components, such as the enabling EPI community.

REFERENCES

Amacher, G. 2004. “Environmental quality competition and eco-labeling.” *Journal of Environmental Economics and Management* 47(2): 284-306.

Antoniou, Zoe, and Dimitris N. Kalofonos. 2008. “User-centered design of a secure P2P personal and social networking platform.” In *Proceedings of the Third IASTED International Conference on Human Computer Interaction*, Anaheim: ACTA Press, p. 186–191.

Cachon, Gerard P., and Martin A. Lariviere. 2005. “Supply Chain Coordination with Revenue-Sharing Contracts: Strengths and Limitations.” *Management Science* 51(1): 30-44.

Dwyer, F. Robert, Paul H. Schurr, and Sejo Oh. 1987. “Developing Buyer-Seller Relationships.” *The Journal of Marketing* 51(2): 11 - 27.

Erhun, Feryal, and Pinar Keskinocak. 2011. “Collaborative Supply Chain Management.” In *Planning Production and Inventories in the Extended Enterprise*, eds. Frederick S Hillier et al. Springer US, p. 233-268.

Farrell, Joseph. 1995. “Arguments for weaker intellectual property protection in network industries.” *StandardView* 3(2): 46-49.

Fliedner, Gene. 2003. “CPFR: an emerging supply chain tool.” *Industrial Management & Data Systems* 103(1): 14-21.

Harrison, Terry P et al. 2004. “e-Business and Supply Chain Integration.” In *The Practice of Supply Chain Management: Where Theory and Application Converge*, Springer US, p. 123-138.

Hevner, Alan R et al. 2004. “Design Science in Information Systems Research.” *MIS Quarterly* 28(1): 75–105.

Jin, Xiao-Ling et al. 2009. “How to keep members using the information in a computer-supported social network.” *Computers in Human Behavior* 25(5): 1172-1181.

Kwon, Ik-Whan G., and Taewon Suh. 2004. “Factors Affecting the Level of Trust and Commitment in Supply Chain Relationships.” *The Journal of Supply Chain Management* 40(2): 4-14.

Lacy, Sarah. 2009. *The Stories of Facebook, Youtube and Myspace: The People, the Hype and the Deals Behind the Giants of Web 2.0*. Crimson Publishing.

Lee, HL, and Seungjin Whang. 2000. “Information Sharing in a Supply Chain.” *International Journal of Technology Management* 20: 373–387.

Linthicum, David S. 2001. *B2B application integration: E-business-enable your enterprise*. 1st ed. Boston: Addison-Wesley.

Manuj, Ila, and JT Mentzer. 2008. "Global supply chain risk management strategies." *International Journal of Physical Distribution & Logistics Management* 38(3): 192-223.

Marturano, Antonio, and Sergio Bellucci. 2009. "A Debordian analysis of Facebook." *ACM SIGCAS Computers and Society* 39(3): 59-68.

McLaren, T, M Head, and Y Yuan. 2002. "Supply chain collaboration alternatives: understanding the expected costs and benefits." *Internet Research: Electronic Networking Applications and Policy* 12(4): 348-364.

Melville, N. 2010. "Information Systems Innovation for Environmental Sustainability. " *Management Information Systems Quarterly* 34: 1 - 21.

Mentzer, J, S Min, and Z Zacharia. 2000. "The nature of interfirm partnering in supply chain management." *Journal of Retailing* 76(4): 549-568.

Mentzer, John, James Foggin, and Susan Golicic. 2000. "Collaboration: the enablers, impediments, and benefits." *Supply Chain Management Review*.

Peffers, Ken et al. 2007. "A Design Science Research Methodology for Information Systems Research." *Journal of Management Information Systems* 24(3): 45-77.

Percival, Robert et al. 2009. *Environmental regulation: Law, science, and policy*. 6th ed. New York, Aspen.

Preece, Jenny. 2001. "Sociability and usability in online communities: Determining and measuring success." *Behaviour & Information Technology* 20(5): 347-356.

Sekar, Ram C. et al. 2007. "Future carbon regulations and current investments in alternative coal-fired power plant technologies." *Energy policy* 35(2): 1064-1074.

Seuring, S, and M Müller. 2008. "From a literature review to a conceptual framework for sustainable supply chain management." *Journal of Cleaner Production* 16(15): 1699-1710.

Teece, David J. 2010. "Business Models, Business Strategy and Innovation." *Long Range Planning* 43(2-3): 172-194.

Vom Brocke, Jan et al. 2009. "Reconstructing the Giant: On the Importance of Rigour in Documenting the Literature Search Process." In *17th European Conference on Information Systems Page (ECIS 2009)*, Verona, Italy, p. 2-13.

Wittie, Mike P. et al. 2010. *Exploiting locality of interest in online social networks*. New York, New York, USA: ACM Press.